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Recommendations for Managing Late-Seral-Stage Forest and Riparian Habitats on the Tahoe National Forest

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SUMMARY

An analysis of management for late-seral-stage (old) forests and riparian areas is underway on the Tahoe National Forest (TNF). A Wildlife and Fish Working Group was organized to review related scientific literature and develop management recommendations for managing important habitat elements in older forests and riparian areas for fish and wildlife. The goal of these recommendations is to provide necessary habitat conditions for maintaining viable populations of fish and wildlife species associated with old-forest and riparian habitats. The TNF will consider the recommendations and other resource values and will develop a proposal for managing old-forest and riparian areas; a new analysis of the LRMP will follow. For additional information on the literature reviewed, refer to the summary documents written by the TNF Wildlife and Fish Working Group.

The recommendations provided here offer a generalized framework for establishing site-specific management programs to maintain viable populations of vertebrate species associated with late-seral-stage forests and riparian areas. The recommendations are intentionally non-prescriptive in many areas. The goal is to provide a general overview of desired-future conditions for landscapes and stands, allowing local planning groups to determine specific project-level details that fit on-site conditions. This approach is a departure from traditional methods which establish quantitative standards for field application. However, TNF biologists agree that rigid standards are rarely founded on sound habitat relationships data, are difficult to measure and monitor, and often conflict with the good judgment of field personnel.

The recommended program for managing old-forest and riparian habitats has the following components: 1) an overall landscape design; 2) desired conditions for riparian habitats; 3) desired characteristics for old-forest habitats; 4) adaptive management elements; and 5) suggestions for implementation.

The proposed landscape design consists of some large blocks of mature forest and a Riparian/Old-Forest Network. The goal for the large blocks is to conserve viable populations of wildlife that are associated with the interior conditions of old-forest habitats. The Wildlife and Fish Working Group assumed that the arrangement for large blocks will be determined through adoption of a new conservation strategy for the California spotted owl. The resulting distribution and arrangement of blocks, in conjunction with the Network proposed here, should then be tested for its adequacies in providing habitat for other interior species, such as fisher and marten. The large blocks should be managed to provide the same habitat attributes as are being recommended for the old-forest zone of the network (large trees, snags, and downed logs and a multi-storied canopy).

A Riparian/Old-Forest Network is the second component of the recommended landscape design. The network provides a continuously connected system of late-seral-stage forest that is centered on watercourses. The network has three components: 1) the riparian zone; 2) the old-forest zone; and 3) connectors.

The *riparian zone* consists of the stream channel, floodplain, and upland areas that influence the stream environment. The recommended objectives for the riparian zone are: 1) to provide a high quality stream environment; and 2) maintain key structural and microclimatic elements in streamside areas that are important for aquatic organisms and wildlife. The elements that are consistently shown to be correlated with high quality stream and terrestrial riparian habitats are: 1) stream temperature; 2) arrangement and recruitment of large woody debris (LWD); 3) sources of organic and inorganic material to the stream; 4) sediment conditions; 4) subsurface water processes; 5) watershed connectivity; 6) composition and arrangement of riparian trees and shrubs; and 7) riparian and upslope microclimate.

The width of the riparian zone should be determined locally to meet and perpetuate these long-term elements. In most cases, the minimum width of the zone would be the potential maximum height of the tallest tree capable of growing on the site, to provide for LWD input into the stream and floodplain (a minimum of approximately 125-200 feet on each side of the channel). However, wider zones may be necessary to provide for the other elements.

The *old-forest zone* of the Riparian/Old-Forest Network increases with stream size. In headwater areas, the old-forest zone generally occupies the same area as the riparian zone; however, the width may be increased to provide for desired microclimatic conditions. In small streams, the old-forest zone is intended to provide travelways for wildlife that measure 150-600 feet on each side of the channel, including the riparian zone. In large streams, the older forests are expected to provide yearlong or seasonal habitat in addition to travelways. In these areas, the old-forest zone measures 600-825 feet on each side of the channel, including the riparian zone, when the channel and floodplain are not a barrier to movement for the associated species. The old-forest zone should be placed on both sides of large streams where the channel and floodplain are judged to be barriers to cross-channel animal movement, and should measure 1200-1650 feet on each side of the channel. Along rivers, the old-forest zone is also intended to provide yearlong or seasonal habitats and travelways for associated wildlife. The zone measures 1200-1650 feet on each side of the channel.

Connectors are included in the Riparian/Old-Forest Network to link late-seral-stage habitats into a completely connected system. The connectors are intended to provide travelways for wildlife and measure 300-1200 feet in width, depending upon the associated furbearer species found there (fisher or marten) and the quality of habitat. Connectors should be arranged so that old-forest habitat in all planning watersheds are linked with that in each adjacent watershed. Linking headwater areas of adjacent watersheds is recommended where feasible.

Habitat relationships data for forest fish and wildlife are insufficient for developing management guidelines based on species habitat preferences. Therefore, the recommended characteristics for old-forest and riparian habitats are the potential natural composition and arrangements of key habitat elements. By using potential natural communities as a management theme, the manager can assume the local species pool will be conserved by providing the conditions with which they evolved. Determining the conditions that represent natural arrangement is not easy for some riparian areas and old-forest stands, often due to the nature of past disturbances. More research is needed on potential natural community composition, vegetation successional pathways, and

patch dynamics for the Sierra Nevada. Yet, local knowledge can typically identify sites that are in obvious need of restoration or maintenance. For riparian areas, providing the natural levels of physical components such as sediment and water temperature is recommended. Providing the potential-natural composition and arrangement of riparian and adjacent upland forest canopy and understory vegetation, is also recommended. Generally, these objectives can be met by extending existing guidelines prescribed in Appendix F of the Forest Plan to all riparian areas. These guidelines prohibit scheduled timber harvest, road building and other ground disturbing activities in riparian areas associated with perennial streams.

Focusing on the potential-natural composition and arrangement of the key habitat elements important for terrestrial vertebrates in old-forests (large trees, snags, and down logs, and multi-layered canopies) is recommended for the large blocks, old-forest zone, and connectors. Determining the arrangements that represent natural conditions is not always possible, but the potential-natural vegetation can be determined on a site-by-site basis. The desired-future condition of these elements, depending on site potential, can be approximated by using the data collected by the Region 5 ecologists during the development of old-growth definitions for the major forest types in the Sierra Nevada.

The recommended program for managing late-seral-stage forests and riparian habitats is offered as a set of working hypotheses that deserve rigorous scrutiny and testing. Several measures are recommended to allow additional analysis of the recommendations. A geographic information system (GIS) with vegetation change simulation capabilities is essential for evaluating the proposed program for managing older forests and riparian habitats. Other software can be linked with a GIS to permit critical analyses of the recommended program or other management on individual wildlife species or species groups over time. In addition, integrated software could permit long-term analyses for wildlife, timber yield, economics, water yield and other resources under alternative management scenarios. These tools should be used by the TNF to complete the amendment to the LRMP and accompanying NEPA analysis. The tools should also be used for project planning. Implementing the fish and wildlife monitoring program in the LRMP and several new research projects to address key information needs are also recommended.

The Tahoe National Forest will undoubtedly require a considerable amount of time to evaluate the recommendations provided by the Wildlife and Fish Working Group. While the analysis proceeds, maintaining options for a forest management program for late-seral-stage forests and riparian habitats is recommended. Options can be maintained by: 1) identifying the lands that would be needed to implement the recommended program; 2) mapping other tracts of older forest that could be used for alternative programs or substitute sites for unsuitable conditions in the recommended landscape; 3) identifying other biologically important areas (ridgetop travelways, unique habitats, biologically rich areas); and 4) describing the effects of project-level management on the habitat conditions of areas identified in steps 1-3 in associated NEPA documents.

Biological diversity was not included within the original scope of this project. However, several appeals of the Forest Plan for the Tahoe National Forest focused on this issue and some recommendations for maintaining biological diversity are made here. Maintaining biological

diversity should involve a program for rare species and communities. A program for managing the remaining species in forest matrices of large bioregions, such as the west-slope Sierra Nevada, is also suggested. Cooperative development of these programs among interested publics, private land owners, and the responsible state and federal agencies is recommended. Completing a biological survey, integrating survey results with the existing California Natural Diversity Database, and completing individual or group management plans are recommended for managing rare species and communities. A considerable amount of the remaining forest matrices should be managed to mimic natural patterns to conserve overall biological diversity. Patterns of natural forests are not completely understood for the Sierra Nevada and the existing landscape may be too disturbed to permit useful studies. However, managers can assume that natural patterns will conserve overall biological diversity. Similar assumptions cannot be made with conventional management and additional research on natural landscape patterns is highly recommended.

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INTRODUCTION

The Tahoe National Forest (TNF) issued a Land and Resource Management Plan (LRMP) on June 14, 1990. Appendix D of the LRMP identified a schedule for developing habitat management programs for 33 individual fish and wildlife species and seven species groups by 2001. Standard and guideline No.23 committed the forest to "immediately begin development of a habitat management program for marten and fisher." Standard and guideline No.25 further committed the forest to "develop a program of management for old-growth forests."

The TNF has received many appeals of project-level decisions and received several appeals of the LRMP that focused on issues such as biological diversity and old-growth forests. Many of the project-level appeals have slowed or halted timber sales. The success of these appeals has prevented the TNF from providing a predictable supply of timber to local communities and illustrates the inadequacies of existing management strategies in dealing with these issues.

In response to these project-level and LRMP appeals and staff recommendations, the TNF elected to consolidate some of the programs identified in Appendix D with program development identified in standard and guidelines No.23 and No.25. The Forest is now developing a comprehensive habitat management program for all wildlife and fish species associated with late-seral-stage (older) forests and riparian areas as a single project. The development of management recommendations is the first action of the project.

A Wildlife and Fish Working Group was organized to develop recommendations for managing key habitat elements of late-seral-stage forests and riparian areas for fish and wildlife. A review of related scientific literature was completed by the working group. A collection of several hundred articles was divided into three broad subject areas: landscape ecology, fish and wildlife habitat relationships in late-seral-stage forests, and fish and wildlife habitat relationships in stream environments and riparian areas. Reviews of the literature were prepared for each subject area. Copies of the reviews are available upon request. Summaries of this literature are presented in the following section.

Recommendations for managing late-seral-stage-forest and riparian habitats were developed from information collected in the literature review. In addition, the Wildlife and Fish Working Group met with scientists knowledgeable in landscape ecology, conservation biology, and fish and wildlife habitat relationships in older forests and riparian areas in the Sierra Nevada. The purpose of this meeting was to discuss and evaluate the tentative recommendations. A draft version of the recommendations was written, incorporating the concepts and other input from the scientists. The draft was subsequently peer-reviewed and the resulting final recommendations are presented here. Refer to Appendix B for a list of critical reviewers and consultants involved in the development of these recommendations.

The recommendations presented here will be combined with prevailing habitat management direction for the California spotted owl. The TNF will consider the recommendations of the Wildlife and Fish Working Group and other resource values and will develop a proposal for managing older forests and riparian areas. A new analysis of the LRMP will follow and a major amendment to the plan is expected.

LITERATURE REVIEW

The first phase of the Old-Forest and Riparian Habitat Planning Project was a review of scientific literature addressing landscape ecology and habitat relationships for fish and wildlife in riparian areas and older forests. Highlights from the literature are described below.

I. LANDSCAPE ECOLOGY

Few studies in landscape ecology are relevant for setting measurable habitat objectives for late-seral-stage forest and riparian habitats on the Tahoe National Forest. However, many concepts and principles from the literature are useful for planning habitat management for forest landscapes.

Landscapes are most easily visualized as hierarchies of pattern generated by processes operating at different scales in space and time. For example, a forested landscape can be organized into several scales such as areas influenced by individual trees, stands consisting of many trees, and mosaics of different stands. Viewed in this hierarchical fashion, a natural landscape may be characterized as having processes and cycles occurring at several scales simultaneously, with each scale containing predictable structural patterns.

Most landscapes can be viewed as having three essential features: a background matrix, patches, and corridors. The matrix is the most extensive and connected landscape element and exerts primary control over landscape function. For western forests, the matrix is usually the late-seral-stage forest. Patches are smaller areas within the matrix (analogous to the "stands" used in forestry) which are categorized by sources of origin. For example, resource patches are areas where inherent environmental conditions differ from their surroundings. Corridors are landscape features which connect similar patches. Patches and corridors may be created by disturbances, such as logging, fire, wind, etc. (disturbance patches), or may be retained when the entire matrix is altered (remnant patches).

Patch dynamics, especially those related to disturbance patches, are of primary importance to forest management. Landscape processes resulting from disturbance patch dynamics within a matrix are largely the result of edge effects. In forested ecosystems, patches induce the positive and negative effects of edges. Generally, large contrasts between patches and the forest matrix produce the greatest effects. The opening of a forest interior initiates secondary succession processes. Different plants and animals adapted to forest openings and edges may colonize these disturbance patches. However, species preferring habitats provided by the forest interior may be subject to increased predation, nest parasitism, and disease, in addition to net habitat loss, as forests are fragmented and the proportion of edge increases. The magnitude of edge effects may be minimized by reducing the number and contrast of patches and increasing the ratio of patch area to perimeter.

When patches are connected with corridors of similar habitat, their degree of isolation is less and the number of associated species will usually be higher than unconnected patches with the same area. In addition, corridors can provide areas for wildlife movement among patches within or between seasons. If corridors are sufficiently wide, they may be used by plants and animals as

seasonal or yearlong habitats. However, corridor geometry can also influence the effects of edge on associated species and long, narrow corridors create more edge effects than wider areas.

The primary regulators of landscape patterns are abiotic factors, biological processes, and disturbances. Each may operate independently or synergistically at many spatial and temporal scales. Important abiotic factors range from fine-scale soil conditions to regional geomorphology. Important biological processes vary in scale from individual organism interactions to community dynamics. Disturbances range from death of an individual plant to large-scale catastrophic events. Vegetation evolves and adapts to abiotic factors, biological processes, and disturbances at different scales and rates. The resulting landscapes are dynamic in space and time.

At all scales, landscapes have homeostatic processes, such as soil formation and vegetation succession, that drive them towards a state of equilibrium in the absence of disturbance. These homeostatic processes, combined with recurring patterns of disturbance, result in natural landscapes that have steady-state conditions with oscillating trends in their components.

Atypical disturbances may greatly alter or break down landscape functions. Such disturbances can disrupt nutrient cycling and species interactions such that the ecosystem cannot return to previous states of equilibrium. In these situations, the regenerative properties of the system may be seriously impaired or lost.

Many strategies of landscape planning focus on the design of areas that will function as reservoirs for biological diversity within an altered landscape. Island biogeography theory has provided much of the background information for the design of these areas. This theory concludes that large, contiguous blocks of habitat conserve more species than a system of small blocks with the same area.

The utility of island biogeography theory for managing forests depends on the condition of the mature forest matrix. The theory is most useful when dealing with highly specialized species in areas where the forest matrix is altered so that only habitat "islands" remain within a "sea" of unsuitable habitat. Despite several potential problems in directly adapting island biogeography theory to terrestrial forested ecosystems, related concepts such as species/area relationships, colonization rates, and isolation of habitat patches will be useful when planning forest landscapes.

II. FISH AND WILDLIFE HABITAT RELATIONSHIPS IN RIPARIAN AREAS

Riparian areas are the three-dimensional interfaces of direct interaction between terrestrial and aquatic ecosystems. These interactions involve many factors and processes, including: microclimate (e.g., light, temperature, and humidity), inorganic and organic matter exchange to streams and floodplains, and nutrient cycling, among others. Vegetation, hydrology, soil character, and topography all determine the type, magnitude, and direction of functional relationships, energy flow, and nutrient cycling in these zones. Riparian areas encompass stream source areas (e.g. springs), the active stream channel and side channels, floodplain, and portions of upland areas that directly affect the aquatic system. Riparian areas vary in width in response to variation in floodplain width, extent of riparian vegetation, and upland conditions and processes.

The physical structure of a stream, coupled with its hydraulics, form a template for biological responses and results in consistent patterns of community structure and function, and organic matter loading, transport, utilization, and storage along the length of a river. The biological community structure and function changes in response to the geomorphic, physical, and biotic variables, such as stream flow, channel morphology, detritus loading, size of particulate organic matter, characteristics of autotrophic production, thermal responses, and changes in stream order. The biological community shift from upstream to downstream is largely due to the influence of the riparian vegetation on the amount of sunlight reaching the stream, organic inputs, and water temperature.

The characteristics that are consistently correlated with high quality habitat for fish and other aquatic biota, such as insects, within stream environments include the following: 1) the potential natural composition and arrangement of riparian and adjacent upland forest canopy and understory vegetation; 2) uninterrupted surface and subsurface water flows; 3) natural (presettlement) stream temperature; 4) potential natural arrangement and recruitment of large-woody debris; 5) natural (presettlement) sediment conditions; and 6) watershed connectivity to allow upstream and downstream migration of aquatic species.

The primary components of high quality riparian habitats outside the stream include: 1) large-woody debris (both standing and down); 2) subsurface hydrologic processes; 3) soil and slope stability; and 4) the potential natural arrangement and composition of riparian vegetation. In addition, upland areas of the riparian zone function as high quality, late-seral-stage forest habitat for many wildlife species. Key habitat elements in these areas include: 1) large overstory trees; 2) large logs; 3) large snags; and 4) multi-layered vegetation. In many cases, these adjacent uplands are extremely important in insulating and stabilizing riparian microclimates and sediment loading and in providing large-woody debris.

Riparian systems provide habitat for many of California's amphibian and reptile species. Amphibians tend to inhabit small stream, headwater, seep, spring, and meadow habitats in forested regions, whereas reptiles increase in warmer, dryer habitats. Most studies have demonstrated or suggested that larger amphibian populations are associated with macrosite conditions that maintain cool, moist stand conditions and microsites that offer large decomposing logs or large pieces of tree bark. Reptiles generally avoid the moist, cool microclimates usually associated with small streams, headwaters, etc., becoming more abundant in the more open, dryer conditions afforded by larger watercourses or smaller watercourses of drier ecotypes.

Riparian areas are a critical link for the maintenance of overall avian species diversity and abundance because they provide high quality habitat and increase the avian habitat suitability of surrounding areas. Riparian zones are important to breeding birds, migrating species, birds of prey, and endangered species. Studies of bird community diversity, richness, and overall abundance demonstrate disproportionate use of riparian areas over adjacent habitat types. This condition has been attributed to several factors including: 1) the presence of diverse and highly productive vegetation; 2) the positive edge effects of streams; 3) the high availability of terrestrial and aquatic insects; 4) the productivity of surrounding area; and 5) the presence of water.

Approximately 25 percent of the mammals found in California are limited to or largely dependent upon riparian or wetland habitats. Key riparian habitat elements for mammals include: 1) riparian vegetation; 2) large overstory trees, snags, and logs; and 3) stand diversity. Characteristics of riparian habitats that also may be important to mammal species include:

availability of water, greater availability of forage (fruits, herbs, deciduous shrubs, mast) than in upland habitats, higher populations of invertebrates, more stable temperatures, linear continuity of habitat, coarser and more friable soils, the presence of multiple seral stages in adjacent uplands, and abundant aquatic and terrestrial carrion. Factors found to be positively correlated with the presence of some small-mammal species include plant species richness, decayed logs or number of logs, number of brush piles, number of stumps, slope, percent shrub and forb cover, evergreen herbs, and deciduous herbs.

Overall, there are few strong empirical relationships between attributes of stream environments or riparian habitats and wildlife use or population trends. Habitat relationships information was reviewed for 23 species identified as having strong habitat associations with riparian areas (see Appendix C). None of the species reviewed appear to be dependent on all the predominant elements of riparian habitats; each species is associated with specific components in a way that differs from the others. When considered collectively, the group of individual species is closely associated with all of the primary components of riparian ecosystems.

III. FISH AND WILDLIFE HABITAT RELATIONSHIPS IN LATE-SERAL-STAGE FORESTS

Overall, there are few studies of wildlife and fish habitat relationships in older forests of the Sierra Nevada. Therefore, habitat relationships information must be largely extrapolated from other regions.

A primary influence of older forests on fish habitat is the recruitment of large-woody debris (LWD) to stream environments. Large wood plays an important role in stream structure and function. For example, LWD provides an important source of nutrients for stream environments, shapes and stabilizes the channels, traps sediment, and creates structural complexity and rearing habitat for salmonids. The influence of the forest on stream environments changes as watercourses enlarge. Forests influence larger streams primarily on the edges, where they stabilize stream banks and create and maintain side channels and backwater areas, whereas forests tend to influence the entire stream channel of smaller watercourses.

Comparisons of wildlife from managed and unmanaged Douglas-fir forests in the Pacific Northwest indicate that very few vertebrates distinguish between managed late-seral-stage forests and unmanaged older forests. Rather, vertebrate species and communities associated with older forests seem to require the stand attributes that increase with age. Large overstory trees, cool and moist conditions on the forest floor, horizontal and vertical habitat diversity, and abundant large logs and snags consistently have been shown to be important habitat components for wildlife associated with older forests. The specific habitat elements that are important vary by species and taxonomic group.

Studies of amphibians and reptiles associated with managed forests have demonstrated similar trends in a variety of locations. Overall, amphibians are significantly more abundant in older forests and increase considerably as young stands mature. Amphibians in the Sierra Nevada fall into two broad groups: 1) amphibians, such as frogs, which are dependent on free-standing water for reproduction or other phases of their life cycle; and 2) completely terrestrial amphibians, such as many species of salamanders, which require moist areas but live their entire life cycle without free-standing water. Most studies have demonstrated or suggested that larger terrestrial

amphibian populations are associated with site conditions that maintain cool, moist stand conditions and provide large, decomposing logs or large pieces of tree bark.

Reptiles are rare in moist, cool, older forests and are most abundant in the youngest stands and warmer, dryer old-forest ecotypes. Disturbed sites that maintain considerable vegetative structure have been shown to support larger reptile populations than sites that have little available structure. The available literature does not identify serious problems or concerns for maintaining reptile species associated with forested habitats at this time. However, habitat relationships information for reptiles in forests is very limited.

Habitat structure has been identified as the primary factor influencing bird communities in managed and unmanaged forests. High densities of large trees, large snags, tree-height diversity, and the presence of a well-developed understory have been consistently correlated with the presence of many bird species in older forests. Higher bird species diversity in older forests is largely due to the increases in these characteristics as stands mature.

In general, there are no major differences in the number of small-mammal species between old and young forests. Most studies have indicated a change in community composition because some species prefer young-aged or recently cut stands and others prefer older stands. The structural characteristics of forests of various ages appear to be more important to mammals than stand age.

Habitat relationships information was reviewed for 16 species identified as having strong habitat associations with older forests (see Appendix C). None of the species reviewed appear to be dependent on all the predominant elements of late-seral-stage forests; each species is associated with specific components of older forests in a way that differs from the others. When considered collectively, the group of individual species is closely associated with all of the primary components of old-growth and late-seral-stage forests.

RECOMMENDATIONS

The Forest Wildlife and Fish Working Group has developed recommendations that are divided into two components. The first addresses long-term management of biological diversity. The second focuses on managing habitats for viable populations of vertebrates associated with old-forest and riparian habitats.

I. LONG-TERM STRATEGY FOR MAINTAINING BIOLOGICAL DIVERSITY

The maintenance of biological diversity was not within the original scope of the Old-Forest and Riparian Habitat Planning Project and is not addressed in detail here. However, the Wildlife and Fish Working Group has concluded that this project and others identified in LRMP Appendix D may not completely maintain overall biological diversity. These projects focus on a subset of individual species and major taxonomic groups of vertebrates, but do not address other plants and animals. Because many appellants of the LRMP raised biological diversity as an issue in their appeals, some recommendations for addressing this issue are presented below.

The Wildlife and Fish Working Group believes that conservation of biological diversity in the Sierra Nevada can best be accomplished by cooperating with other managers. Therefore, programs for maintaining overall biological diversity should be cooperatively developed. Cooperators should include other agencies and publics with responsibilities or interest in biological diversity. A long-term strategy for maintaining biological diversity in the Sierra Nevada could be effective if it included the following elements:

A. Management of Rare Species and Communities

It is unlikely that any long-term program for maintaining biological diversity can be accomplished without devoting some attention to rare species and communities. Therefore, a program for managing rare resources is recommended. The program should include the following components:

Biological Surveys. Comprehensive biological surveys are needed for many provinces of California. The surveys should include the inventory and mapping of a significant range of biological resources. Cooperative planning and management may provide sources of funding for this work that has been lacking.

Database Management. The California Natural Diversity Database (CNDDB) has been developed to organize, describe, and map rare species and communities. Data from a comprehensive biological survey could be organized within the existing CNDDB for use at several scales.

Individual Management Plans. After biological survey information is organized in the CNDDB, development of management plans for individual species or communities should be completed by appropriate agencies and interested publics.

B. Managing the Remaining Forest Matrix

Managing forest lands for rare species and communities can be expected to affect a relatively small portion of the overall landscape of the Sierra Nevada. A considerable portion of the remaining forest matrix should be managed to conserve the remaining species and communities.

Traditional management that focuses on habitat relationships for a few organisms and establishes discrete areas for each is not recommended where maintaining biological diversity in the forest matrix is an objective. This approach assumes that habitat relationships for a few target species represent relationships for all organisms. This approach has been criticized by Forest Service scientists and others, and may not be appropriate for many areas today. Similarly, assuming that ongoing forest management practices will conserve biological diversity is not recommended. Managed forests of the Pacific Northwest have been shown to result in patterns that substantially reduce structural complexity and reduce the key habitat elements that have been consistently correlated with high wildlife use and diversity.

Hierarchy theory offers an alternative method for managing complex forest ecosystems. Hierarchy theory can be applied to landscapes to describe patterns that are generated by processes operating at several scales. Ordering landscapes into hierarchies allows managers to observe that nonequilibrium dynamics or spatial heterogeneity at one scale can be organized into

equilibrium or constancy at a higher level. Therefore, consistent patterns in characteristics such as patch type and size can be described for natural (presettlement) forests at several scales (see Table 1).

Resource management can be scaled to mimic natural patch dynamics where conservation of biological diversity is a goal. This approach takes advantage of preselected adaptive mechanisms in local species pools. Mimicking natural patterns is a very attractive approach because it allows the manager to assume that biological diversity will be conserved on a landscape that provides the patch characteristics at varying scales within which the local species pool evolved.

The patterns of presettlement forests are not understood at any scale in the Sierra Nevada today. Furthermore, the landscape of the Sierra may have been sufficiently disturbed that understanding presettlement patterns may not be possible. Others have argued that landscapes are so dynamic in space and time that focusing management on presettlement patterns is unwise. Yet these patterns can be assumed to maintain desirable levels of biological diversity and this approach offers a powerful alternative to conventional management. Therefore, pursuit of information about presettlement patterns in forested landscapes of the Sierra Nevada is highly recommended.

Table 1. Recommended scales for researching hierarchies in forest ecosystems

Scale	*Description*	*Size (ac)*
a. Gaps	Areas influenced by large trees	.02 - 0.25
b. Stands	Aggregates of similar vegetation	2 - 250
c. Watersheds	Order 3-4 drainage basins	2,500 - 25,000
d. Landscapes	Physiographic provinces or major plant associates	> 250,000
e. Regions	Physiographic Regions - West Slope Sierra Nevada	> 2,500,000

II. MANAGING HABITATS FOR VERTEBRATES ASSOCIATED WITH OLDER FORESTS AND RIPARIAN AREAS

The recommendations provided here offer a general framework for establishing site-specific management programs for late-seral-stage- (old-) forest and riparian habitats for vertebrate species. The recommendations are intentionally non-prescriptive in many areas. The goal is to provide a general overview of desired-future conditions for landscapes and stands, allowing local planning groups to determine specific project-level details to fit local conditions. This approach is a departure from traditional methods which establish quantitative standards for field application. However, TNF biologists agree that rigid standards are rarely founded on strong habitat relationships data, are difficult to measure and monitor, and often conflict with the

good judgement of field personnel. We expect some variation of these conceptual guidelines to be made at the interdisciplinary team level on a project-by-project basis, within the forest-wide framework.

The recommended program for managing late-seral-stage-forest and riparian habitats consists of the following: 1) desired landscape configuration, including the desired conditions for riparian areas; 2) recommended stand conditions for late-seral-stage forests; 3) adaptive management elements; and 4) suggestions for program implementation.

A. DESIRED LANDSCAPE CONFIGURATION

The recommended landscape design for late-seral-stage-forest and riparian habitats (Old-Forest/Riparian System) consists of scattered, large, old-forest-habitat blocks connected by a Riparian/Old-Forest Network (Figure 1). The design is intended to provide a completely connected system of habitats for associated vertebrate species. The system was designed to combine the advantages of a large block strategy and a habitat network. It reflects the principles of conservation biology that relate to species associated with old-forest and riparian habitats described by others as follows:

* Species that are well-distributed across their range are less prone to extinction than those that are restricted to a portion of their former range.

* Large blocks containing many pairs of each species will sustain species better than small blocks with few individuals.

* Blocks of habitat that are close together are better than those that are far apart.

* Contiguous, unfragmented habitats are better than fragmented areas.

* Habitat is generally more useful for dispersal, daily movements, and migration if it closely resembles suitable habitat for a species in question.

* Connected blocks of habitat are better than unconnected blocks of habitat.

* Management strategies that provide habitat throughout the landscape are more able to withstand large disturbances than those that concentrate habitat.

1. *Habitat Blocks*

Large, contiguous habitat blocks are recommended as a major component of an old-forest habitat management program because these blocks can provide critical habitat for species that live in the interior of mature forests. Large areas of interior-forest habitats are needed to maintain viable populations of these animals that are adversely affected by processes that are commonly associated with forest edges, such as increased nest parasitism and predation. Fragmented or linear habitats are subject to high degrees of edge effects. Therefore, the primary objective for habitat blocks should be to provide areas of interior forest habitat that are sufficiently large and unfragmented to eliminate or significantly reduce the effects of edges on associated species.

Conservation biology literature suggests that methods for designing habitat blocks should focus on two primary actions: 1) choosing a wide-ranging predatory animal as the surrogate for analysis; and 2) developing a program that establishes blocks of habitat in an arrangement that conserves stable subpopulations of the target species throughout their present or historic range. These two actions were recently completed for the northern spotted owl and a system of habitat conservation areas (HCAs) was recommended. Alternative conservation strategies for the California spotted owl are presently being evaluated.

In the absence of an updated conservation strategy for the California spotted owl, the Wildlife and Fish Working Group assumed that the future conservation strategy will resemble that proposed for the northern spotted owl. Therefore, the management strategy for spotted owls is assumed to provide the necessary guidelines for determining the sizes and distribution of large blocks of old-forest within suitable spotted owl habitat. These large blocks should also be managed to conserve other vertebrate species that are associated with habitats on the interior of late-seral-stage forests and, therefore, should be managed for the same habitat attributes recommended for the network (see section II-B, p.23).

If habitat conservation areas (HCAs) are not chosen as the management strategy for the California spotted owl, the TNF will revise the recommendations for managing late-seral-stage forests to reflect prevailing management for the subspecies. Further, if the strategy for the California spotted owl does not provide large, contiguous blocks of old-forest habitat, the availability of forest-interior habitat with the chosen management strategy will be evaluated. Adjustments in the program will be recommended as needed to provide for other species associated with interior zones of older forests.

In addition, the following recommendations relate to management of large blocks of late-seral-stage forests:

a. To conserve populations of wide-ranging species such as marten and fisher, some small (1,000 - 3,000 acres) blocks or other arrangement of older forest may be needed to supplement the block and network design proposed here. The need for the blocks as well as their proposed sizes and arrangement cannot be adequately described with available information. See section II-C-1 (p.25) for recommendations that address this condition.

b. More information is required regarding wildlife relationships in eastside-pine forests. The need for large blocks of interior late-seral-stage forest in eastside-pine is presently unclear. Historical information suggests that this forest type did not generally occur in large blocks of closed-canopy, mature forest under natural conditions. However, large blocks of eastside-pine with structural features that better represent the potential natural community in this vegetation type may be necessary to sustain well-distributed, viable populations of vertebrates on the TNF. Therefore, eastside-pine forest ecosystems need to be more intensively investigated before wildlife management direction can be adequately addressed by the TNF. Currently, the Wildlife Working Group is planning an eastside-pine workshop to further address the wildlife relationships of this zone. This workshop will occur within the next three months and the conclusions will be appended to this document.

2. *Riparian/Old-Forest Network*

The Riparian/Old-Forest Network is intended to be a continuously connected system of late-seral-stage forests that is centered on stream channels and rivers. The old-forest zone is centered on stream channels to take advantage of the geomorphological stability of the stream environment. The primary purpose for managing associations of older forests and riparian areas is to allow for the continuation of natural processes and associations between plants, animals, and abiotic factors found in old-forest habitats, riparian habitats, and their ecotones. Riparian-associated forests are often less susceptible to fire due to the microclimatic conditions found there. In addition, arranging the network in this manner will provide increased protection for water quality and stream and riparian habitats. Riparian areas have also been described as natural movement corridors for wildlife associated with older forests. Further, this arrangement appears to be the most efficient, allowing the upland area of the riparian zone to also be included in the old-forest zone.

Our goal is to provide a general overview of desired-future conditions for landscapes and stand, allowing local planning groups to determine specific project-level details to fit local conditions. The recommended network has three components: 1) the riparian zone; 2) the old-forest zone; and 3) connectors.

a. The Riparian Zone - Desired Landscape Configuration and Conditions

The proposed riparian zone for all perennial and intermittent streams consists of the wetted channel, 100-year floodplain, riparian vegetation, and the upland areas that influence key attributes of the stream environment (Figure 2). These attributes include: stream temperature, stream sediment supply, flow, channel stability and structure, availability of organic material, and aquatic biota, as well as overall terrestrial microclimate.

The primary objectives for riparian zones are to: 1) provide high quality stream environments; and 2) to maintain the key structural and microclimatic components in streamside areas that are important for aquatic organisms and wildlife. Generally, the upland areas that influence the stream environment and floodplain in headwater areas are similar in dimensions to those in lower stream reaches. Therefore, similar widths of upland areas are proposed along most segments of a stream or river system. However, because floodplain width often increases downstream, the overall riparian zone width will generally increase downstream. The widths of the upland areas should be determined by project-level interdisciplinary teams to meet and perpetuate the long-term objectives and recommendations discussed below and summarized in Table 2. In most cases, the minimum width of this zone would be the potential maximum height of the tallest tree capable of growing on the site; this will provide for large-woody debris input into the stream or floodplain. However, the width can increase depending on the site-specific conditions. Wider zones may be necessary to provide for other desired attributes important for aquatic organisms and wildlife, such as natural (presettlement) stream temperatures, potential natural microclimates, potential natural sources of organic and inorganic material to the stream, undisturbed subsurface water flow processes, watershed connectivity, and potential natural composition and arrangement of riparian vegetation.

In addition, upland areas of the riparian zone can also function as high quality late-seral-stage-forest habitat for many wildlife species. Key habitat elements in these areas include: large overstory trees, large logs, large snags, and multi-layered vegetation. The importance of

these attributes and suggestions on how to provide them over time are described below and summarized in Table 2.

Overall, there are very few strong empirical relationships between attributes of stream environments or riparian habitats and wildlife use or population trends. However, maintaining the potential natural composition and arrangement of the key habitat elements that are consistently shown to be correlated with high habitat quality can be used as an alternative management theme. By mimicking natural habitat conditions and patterns in which the local species pool evolved, the manager can assume that associated animals will be conserved.

To maintain the key habitat elements in the complex riparian ecosystems on the Tahoe National Forest, management in the riparian zones described above should follow the management direction in LRMP Appendix F. Appendix F generally prohibits management activities that disturb soils or remove vegetation in these areas, except for activities which directly benefit riparian-dependent resources.

The key elements for providing high quality stream environments and the key habitat elements for riparian-associated wildlife are described in detail below.

Maintaining Water Temperature. Small, undisturbed headwater streams are often completely shaded by riparian vegetation. These small streams contribute cool water to more-open downstream reaches. Small increases in water temperatures from streams throughout a basin may lead to an overall warming of lower stream reaches, creating unfavorable environmental conditions for many aquatic species. These species tolerate different ranges of temperature, depending on their oxygen requirements, reproductive habits, and feeding habits. For example, most trout species will not survive if water temperatures exceed 70° F for extended periods. At warmer water temperatures, salmonids become more susceptible to disease and may suffer indirect mortality from competition with other fish species that tolerate warmer water ecosystems.

Sources of cold water throughout a basin are vital for riparian resources. Biologists generally agree that keeping stream temperatures at natural (presettlement) levels is desirable. Therefore, shade provided by naturally-occurring or potential natural riparian and upland vegetation should be maintained or provided throughout a drainage basin.

Managing Large-Woody Debris. In all stream orders, large-woody debris (LWD) plays a vital role in stream structure and nutrient cycling. It is important to leave trees in and around riparian zones as future sources of large-woody debris as well as for controlling stream temperatures through shade.

For long-term LWD recruitment, riparian zones need to include large standing trees that can later fall into the stream and floodplain. The upland areas in riparian management zones should be delineated starting at the edge of the 100-year floodplain rather than starting at the stream edge. For example, a perennial stream with a wide (>100 foot) floodplain should have a riparian management zone that includes the entire 100-foot floodplain and an area that extends into the upland forest at least as far as the potential maximum height of the tallest tree capable of growing on the site.

Woody debris from logging activities tends to form unstable habitats in streams, because logging debris often lacks branches and rootwads. This structural material can be highly mobile in a stream environment. Large-woody logging material can adversely affect stream channel habitats by destabilizing channels and creating debris jams, often resulting in major blow-out and scouring events. Input of new woody-debris material into streams during logging and road construction should be avoided. Pre-existing stable pieces of LWD should not be disturbed, and "cleaning" of the stream channel and riparian zone should be avoided.

Since the upland forest portion of the riparian zone is designed, in part, for the recruitment of LWD into the stream channel and floodplain, blowdown and downed trees should not be removed from the riparian zone. Windthrow is the most common source of natural debris recruitment. A blowdown event associated with management activities outside the zone often accelerates debris recruitment, but it is not an undesirable condition.

Appendix F of the LRMP generally prohibits scheduled timber-harvest in the streamside management zone. This direction, applied to the zone described here, will adequately conserve sources of large-woody debris for the stream environment.

Sedimentation. Riparian areas act as buffers and filters of mobile sediments. The abundant and diverse plant communities of intact riparian areas help ensure stream flows that are low in suspended sediments and turbidity. Vegetation and ground cover within and around the riparian zone are important throughout the watershed for the prevention of accelerated sediment inputs to streams. Sediment entering headwater channels travels downstream, compounding sediment inputs in lower stream reaches and creating the potential for negative cumulative effects. Maintaining vegetation and ground cover on small headwater streams, intermittent streams, and ephemeral drainages, as well as perennial streams, greatly reduces the risk of negative cumulative effects of sedimentation on drainage basins.

Physical changes in stream habitat composition due to sedimentation often negatively affect aquatic biota. One result is a shift in species composition and age structure, decreasing those species and age classes dependent on pools and substrate interstices while favoring those that prefer riffles. Sediment deposition over stream beds reduces the habitat available for aquatic insects and may result in oversimplified benthic communities, depleted of many or all of the species once found there. Even at relatively low levels, fine sediments deposited in fish spawning areas can kill eggs or emerging fry. At higher concentrations, suspended sediments can damage fragile gill tissues of fish. Management practices that increase sediment loads to streams can severely impact the aquatic fisheries resource.

The relative stability of a channel can significantly affect the amounts of sediment transported by the stream. Management activities in stream channels and their associated riparian zones often result in accelerated, unnatural levels of sediment loading. The deposition of sediments following management activities can alter the stream habitat composition by filling and decreasing pool volumes and increasing fine sediments in riffle habitats.

Throughout a drainage basin, plant roots and large-woody debris accumulations in riparian areas help to stabilize stream banks and hill slopes. This, in turn, reduces sediment inputs to streams. During floods, riparian areas dissipate the water's energy, causing suspended sediments to settle out instead of being transported farther downstream. Riparian areas with broad floodplains

act as additional storage sites for sediment and water. To prevent vegetation and ground disturbance, guidelines stated for perennial streams in the Tahoe LRMP Appendix F should be followed for the riparian zones recommended here. The guidelines state that management activities shall be excluded from stream management zones, except in cases where activities will benefit riparian dependent-resources.

Maintaining Floodplain Areas. The topographic break in slope between hillsides and the relatively flat floor of the river valley defines floodplain boundaries. Floodplain habitats offer areas of lower water velocities and shallow water depths during high flows. These areas also serve as depositional zones and refugia for small fish and aquatic organisms during flood events. Floodplain areas can be highly productive and nutrient-rich during and following periods of water inundation.

The entire 100-year floodplain and associated stream channels should be included within the riparian zone to allow stream channels to meander over time. This movement promotes the balance between stream energy (channel gradient coupled with hydraulics) and stream processes, such as erosion, deposition, and nutrient cycling.

Channel Stability. Channel stability can influence all aquatic biota. A stable channel often provides cover and a diversity of stream habitat structures, which increases hydraulic diversity. Fish prefer habitats low in fine sediments and high in cover and structural diversity. Unstable channels often experience bank cutting and accelerated erosion, which result in increased sediment inputs. Stability of a stream channel is closely tied to geomorphology, riparian vegetation composition and vigor, and soil stability. Channel stability can be directly influenced by management activities in the riparian zone and in the adjacent upslope areas. Exclusion of management activities requiring vegetation removal, ground disturbance and heavy equipment should be applied to all riparian zones, as described for perennial streams in Appendix F of the LRMP.

Managing Riparian Vegetation to Maintain High Quality Stream Environments. Natural disturbance processes often lead to multi-seral-stage riparian vegetation. The structure and complexity of multi-layered, patchy vegetation maintains a high diversity of aquatic and terrestrial species in stream and riparian ecosystems.

The riparian zone vegetation influences physical factors such as light, temperature, humidity, and structure. Vegetation in riparian zones also helps to stabilize stream banks, decreases erosion potential by reducing surface disturbance, prevents down-cutting which can lead to dropping of the water table, and traps and transforms nutrients, chemicals, and sediments through the maintenance of surface and subsurface hydrologic processes. Land-use practices can modify one or more of these factors. To ensure high overall stream quality, the riparian vegetation along all stream reaches and springs should be maintained in a pattern that represents the potential natural species composition and arrangement.

Maintaining Connectiveness in the Watershed. Flow is a basic element of streams. This stream attribute needs to be maintained to support the natural compliment and abundance of aquatic

species, and to promote their unimpeded movement throughout the stream system. Aquatic organisms use different habitats and portions of the stream at various life stages. All stream reaches that can support fish and aquatic insects need to be available in order to allow access to all critical habitats, maintain genetic exchange, and prevent separation and local extinctions of aquatic populations. Unnatural structures and activities that can result in an interruption of adequate streamflow include: hydro-electric projects, water diversions, culverts, and water drafting. Thorough and rigorous analysis and consultation with a hydrologist, fish biologist, and wildlife biologist should be conducted when any interruption in streamflow is anticipated by a management activity.

Riparian Vegetation as Wildlife Habitat. Many species of wildlife are associated with riparian habitats because of the unique characteristics of riparian vegetation. The trees, shrubs, and herbaceous plants that depend on riparian areas offer additional habitat diversity that strongly influences the high levels of associated animal diversity in these areas. There are few well-established relationships between specific arrangements of key habitat features and wildlife use of riparian vegetation. However, sites that provide potential natural riparian vegetation can be expected to conserve associated species. Determining the conditions that represent the potential natural arrangement is not easy for some riparian areas, often due to the nature of past disturbances. More research is needed on this subject. Yet, local knowledge can typically identify sites that are in obvious need of restoration or maintenance.

Large Overstory Trees, Snags and Logs. Large trees in the overstory of upland areas provide a critical habitat component for some species associated with riparian zones. An overstory of large trees is also needed to maintain other key attributes of older forests and some riparian habitats such as cool, moist soil conditions and large snags and logs. All of these elements should be maintained in the upland areas in riparian zones for wildlife. Management direction in Appendix F of the LRMP generally prohibits management activities that remove vegetation in streamside management zones and, when applied to the riparian zones recommended here, should maintain these key habitat components for wildlife.

Stand Diversity. Vertical and horizontal habitat diversity appear to be critical habitat components of riparian zones for some species. These relationships are not entirely clear. A small number of animals appear to prefer habitat with open canopy conditions. However, areas that provide multiple layers of vegetation on a vertical scale can be expected to produce higher numbers of species. This relationship will be most consistent when each layer adds new life requisites for local species. Providing riparian habitats with both open and closed canopy conditions, as well as varying conditions in the understory, will be needed for management of the entire vertebrate community associated with riparian areas. Site-specific variation in the potential natural composition and arrangement of vegetation in the riparian areas should provide these diverse conditions in the riparian zone.

Table 2. Objectives for Desired Future Conditions in Riparian Zones

Objective	*Recommendations*
Provide natural (presettlement**) stream temperatures through time.	Provide natural composition and arrangement of adjacent forest canopy and understory vegetation (herbs, shrubs, and small trees).
Provide the potential natural arrangement of large-woody debris in all time periods.	Establish upland areas to protect all existing and natural and potential sources of large dead wood. Upland areas should be at least as wide as the potential maximum height of the tallest tree capable of growing on the site.
Provide the potential natural sources of organic and inorganic material to the stream environment through time.	Provide the potential natural composition and arrangements of riparian vegetation and adjacent forest canopy and understory vegetation.
Provide natural (presettlement**) sediment loads in stream channels over time.	Provide adequate ground cover and vegetation in the upland areas as sediment buffers. Rehabilitate disturbed sites. Eliminate ground-disturbing activities in the zones.
Provide undisturbed surface and subsurface water flow processes over time.	Prevent ground-disturbing activities in the riparian zones. Maintain stability in sensitive upslope areas.
Provide watershed connectivity for movement of aquatic organisms in all time periods.	Provide adequate flows and fish passage structures. Regulate activities that drain or reduce stream flows to provide adequate watershed connectivity.
Provide potential natural composition and arrangements of riparian trees and shrubs for wildlife through time.	Use best professional judgement to establish estimates of potential natural communities. Restore native tree and shrub assemblages, where they have been degraded or eliminated. Maintain natural conditions where they exist.
Protect riparian and associated upslope microclimatic conditions through time.	Determine zone widths needed over and above all other recommendations to provide adequate buffering of sensitive microclimatic conditions (See discussion under Late-Seral-Stage Habitats, P. XX).

** *Management should attempt to provide conditions which existed during presettlement periods where possible. Where not possible, management should provide conditions that are as close to presettlement conditions as possible.*

b. The Old-Forest Zone - Desired Landscape Configuration.

An upslope area that includes, but can extend beyond, the upland habitat in the riparian zone is recommended for management of wildlife associated with older forests. The goal for the old-forest habitat portion of the network is to provide yearlong or seasonal habitat and free movement travelways for vertebrate species associated with these areas. Without a GIS and associated vegetation and spatial wildlife species simulators (see Adaptive Management Elements, p.25), it is not possible to determine how many or which streams and rivers are needed to maintain viable populations of associated vertebrate species on the Tahoe National Forest. In the absence of these tools, an association of old-forest zones and riparian zones should be provided adjacent to all perennial and selected intermittent streams where the land is capable of producing the desired natural vegetation. The addition of the old-forest zone to the riparian zone of intermittents should be determined at the project level. Factors influencing this determination include known sightings of associated species, the presence of important habitat for associated vertebrates (e.g., see discussion of amphibian needs under "headwaters", p. 19), and improvement of habitat connectivity. Habitat connectivity is a short-term, as well as a long-term, goal. If suitable habitat connectivity cannot be met along perennials in the short-term, additional intermittents should be added where they are capable of providing a temporary source of suitable habitat to the network.

By connecting the large blocks of old-forest habitat, the network will increase the value of the blocks to associated vertebrate species. In addition, by providing habitat throughout the landscape, the network can withstand local catastrophic events.

As stream sizes increase, the upland area that is managed for late-seral-stage wildlife habitat should be extended over an increasingly wider area beyond the riparian zone (see Figure 2). This recommendation is made because it more closely mimics perceived natural conditions and patterns and overall wildlife diversity generally decreases with increased elevation. For example, in some vertebrate groups, such as birds, more species occur along lower reaches than along upper reaches of drainages. For most vertebrates associated with older forests, this arrangement, in combination with the large blocks, would provide sufficient yearlong/seasonal and travelway habitat to maintain well-distributed, viable vertebrate populations on the TNF.

To simplify implementation, the recommendations for late-seral-stage habitats in the riparian/old-forest network are divided into four categories: headwaters, small streams, large streams, and rivers. These categories are not related to hydrology, but help determine where to manage for different objectives (small species habitat, travelways, and yearlong/seasonal habitat) on the landscape.

The distances of stream segments subject to the varying widths of the old-forest zone (see Table 3) presented in these recommendations are arbitrary. They are meant to serve as a representative distance with the purpose of limiting the amount of the network NOT designed for yearlong or seasonal habitat. For the network to function properly, a high proportion of the system must adequately provide long-term habitat for most old-forest related species. Limiting habitat to travelways for highly mobile species or habitat for very small vertebrates will not provide suitable conditions of all species. Table 3 describes these categories generally, to help managers identify them site-specifically.

Table 3. Stream Category Descriptions.

Stream Category	*Description*
Headwaters	Places of stream origins. Usually first order perennial streams, springs, or intermittent streams. The stream channel does not impede animal movements. Distinct riparian vegetation is often abundant. Areas classified as headwaters should rarely exceed 900 feet in length (Figure 2).
Small Streams	Mostly first-third perennial and intermittent streams. The stream channel does not impede animal movements. Distinct riparian vegetation is variable, but does not usually completely shade the channel when present. Small streams are also characterized by narrow floodplains and adjacent forest habitats commonly shade the channel for most of the day. For the purposes of this document, small streams should rarely exceed 1 mile in length (Figure 2).
Large Streams	Large streams may be third order or larger. In lower reaches, the stream channel may act as as a barrier to normal movement for many species associated with adjacent old-forest habitats. Large assemblages of riparian vegetation are often common and may function as barriers to forest-dwelling species. Large streams often have wide floodplains (Figure 2).
Rivers	Rivers are the main watercourses on the Forest. Examples are all forks of the Yuba. Along its length, the river channel acts as a barrier to normal movement for many species associated with adjacent old-forest habitats. Large assemblages of riparian vegetation are common. Large streams often have wide floodplains (> 100 feet). The stream channels of rivers are usually unshaded over large sections for much of the day (Figure 2).

The upslope area adjacent to these four stream categories have different objectives with regard to the type of habitat they provide to the network (see Table 5). Therefore, different widths are recommended, as described below and summarized in Table 5. There have been no assumptions made about the management of areas outside the network.

HEADWATER AREAS should be managed primarily to provide the microclimate and habitat attributes important for amphibians and small mammals. Attributes important for these species are large trees, large logs and large pieces of tree bark, large snags, and macrosite conditions that maintain cool, moist forest floor microclimates and moist, friable soils. The

stream channel and floodplain are probably not a barrier to movement and, therefore, should be counted as habitat within the old forest zone.

At a minimum, the old-forest zone in headwater areas should be as wide as the riparian zone. This will allow for recruitment of large-woody debris; however, microclimatic, hydrological, and geomorphological concerns might increase the width.

There have been few studies which have looked at buffering widths needed to provide microclimatic stability. One study found that a distance of two to three average tree heights, measuring from the edge into the forest, is required to ameliorate atmospheric effects from the edge. The Tahoe National Forest should investigate this matter further, with the aid of physical scientists. The widths needed to maintain potential natural microclimate, including moist forest floor conditions and friable soils, should also be determined on a site-specific basis by an interdisciplinary team (IDT). At a minimum, the IDT should consist of a soil scientist, a plant ecologist, a hydrologist, and a wildlife biologist.

In addition, there is a concern among herpetologists that a width of one tree height on either side of headwaters may not be wide enough to maintain microclimate conditions necessary for amphibians. No known amphibian species (not all Sierran species have been found) on the TNF is associated solely with headwater streams. Some species, like the mountain yellow-legged frog, rely on habitats where free standing water is available (streams, springs, ponds, lakes). Others, like salamanders, are primarily terrestrial and found in moist, cool areas such as downed logs, seeps, springs, wet talus slopes, and meadows, as well as ponds, lakes, and headwaters. Yet, headwater habitats provide valuable refugia during times of drought stress, when less-moist areas have dried. Places that can maintain cool, moist conditions during drought periods are especially critical habitats for amphibians in the Sierra Nevada. Regardless of habitat type, recent studies of Sierran amphibians show a remarkable amount of differentiation between individual populations, primarily due to the low mobility of these species and isolation of their populations.

Using headwater areas as connectors to adjacent watersheds is one way to increase the width of these areas where microclimatic conditions may be a concern (see p.23, Connectors, for further discussion).

The objective of the upland old-forest habitat adjacent to **SMALL STREAMS** is primarily to provide travelways for the full range of species associated with old-forest and riparian habitats (see Appendix C). The stream channel and floodplain are probably not a barrier to movement and should be counted as habitat within the old-forest zone. It is recommended that the minimum width of this zone be based on the requirements of fisher and marten, which have the largest spatial requirements of the older-forest-associated species in the Sierra Nevada. The minimum width requirements for travel are listed in Table 4.

Table 4. Minimum Corridor Width Requirements.

Species	*Unfragmented habitats (ft)*	*Fragmented habitats* (ft)
Marten	300	600
Fisher	600	1200

Source: Freel, M. 1991. A Literature Review for Management of the Marten and Fisher on National Forests in California. USDA FS PSW unpublished mimeo, 22pp.

The widths used for Table 4 are those classified as "high" capability, which is defined as "habitat which supports a stable population of fisher and/or marten where home ranges occur at relatively high densities suggesting abundant availability of preferred habitat characteristics and high prey densities." "High" capability is used instead of "moderate" (which also supports a stable population but with "lesser availability of preferred habitat characteristics and lower prey densities"), for the following reasons: 1) moderate habitat doesn't maintain the structure necessary for other associated vertebrate species; 2) scientists suggest that these species may require small blocks but are unable to determine size and arrangement (therefore, small blocks are not proposed in these recommendations and maintaining high capability within the network is desirable); and 3) these widths assume that all the habitat is suitable, though habitat outside and adjacent to travelways may be fragmented. Initially, habitat in the proposed network will probably be fragmented due to past management activities and catastrophic events and, therefore, wider areas would be needed to provide sufficient habitat. Initial analysis has indicated that, in some areas, the habitat is very fragmented.

These widths are divided by species and by degree of fragmentation of habitat. The actual width used should be based on best professional judgement on a site-specific basis. The selection of species should include information such as historical sightings of fisher and/or marten, presence of suitable habitat, historical range of the species, and the opinion of researchers regarding the likelihood of occurrence.

The methods used for determining the degree of fragmentation are expected to change over time. In arriving at this determination, best professional judgement should be used which incorporates the most recent scientific information. The current furbearer model assumes suitable habitat within the travelway and refers to the degree of fragmentation outside and adjacent to the travelway, but does not refer to the scale at which fragmentation should be determined. Mapping available habitat within watersheds will allow for a landscape-based determination. This will give a visual indication of the degree of habitat fragmentation. If the habitat is not contiguous (connected), other factors to use in the determination include: 1) size, number, and distribution of habitat patches (e.g., the current furbearer model indicates that minimum patch size for strictly presence/absence of furbearers is 60 acres); and 2) shape of patches and how that relates to the amount of edge and, therefore, amount of actual interior habitat (see Literature Review section I., p.2);

The objective of the upland old-forest habitat adjacent to **LARGE STREAMS** and **RIVERS** is to provide yearlong and/or seasonal habitat and travelways for the full range of species associated with old-forest habitats (see Appendix C). The stream channel and floodplain may be a barrier to movement for species with home ranges larger than the old-forest zone on one side of the channel. For species that will not cross the stream channel or floodplain, local populations should be conserved by providing the old-forest zone on both sides of the channel. Therefore, where the channel and floodplain are a barrier to movement, the zone should occur on both sides of the stream channel, beginning at the interface of the 100-year floodplain and adjacent upland. Where no barrier exists, the riparian channel and floodplain should be counted as habitat within the old-forest zone. The old-forest zone should measure 1200 to 1650 feet in width, in order to accommodate home ranges or minimum-patch-size requirements of the associated vertebrates. The 1650 foot zone guideline is recommended for typical planning areas (see Appendix A for a detailed explanation and other useful data).

The sites where a stream channel or riparian habitats become movement barriers should be determined by project-level analysis. Several useful methods for determining these locations are available, including: 1) use combined analyses of channel width, water depth, and adjacent habitat features; 2) use a measure of home-range diameter for species most likely to perceive the stream as a movement barrier, or 3) use an arbitrary measurement that relates the characteristics of animal movement to stream processes, such as the likelihood of a tree falling completely across the stream channel and floodplain. All methods are acceptable. However, selection of a measurement that relates to animal movement is recommended. Where the floodplain is sufficiently wide and open that necessary cover or other habitat needs are lacking (e.g. the species views the area as "non-habitat"), animals are likely to perceive the stream channel and/or floodplain as a barrier.

3. Connectors.

The objective for connectors is to link habitat blocks and the Riparian/Old-Forest Network across the landscape (Figure 3). The primary function of these areas should be to provide travelways for species associated with older forests. Therefore, the minimum widths for connectors should be determined from Table 4 (see p.19, the narrative on "small streams", for further discussion). Connectors should be arranged so that each planning watershed is linked with all adjacent watersheds. It is desirable to locate connectors over ridges to join headwater areas of adjacent watersheds where possible (Figure 3).

The number and placement of connectors will vary locally depending on: 1) the size and shape of suitable habitat; 2) the quality of the habitat; 3) the potential ability of a site to develop suitable habitat in the future; 4) nearby areas that may provide a substitute connector, either in the short-term or the long-term; 5) land ownership patterns; and 6) past, present, and future land-management practices. High variability in these conditions from site-to-site makes specific recommendations regarding location and frequency of connectors impractical.

Table 5. Objectives for the Old-Forest Zone of the Riparian/Old-Forest Network.

Objectives	*Recommendations*
Headwaters	
Provide potential natural arrangements of large trees, logs, and snags for amphibians and small mammals.	Establish upland areas to protect all existing and potential sources of large dead wood. Upland areas should be at least as wide as the potential height of the tallest trees capable of growing on site (Same as determined for the riparian zone).
Provide forest floor microclimate that resembles natural conditions.	Provide for the potential natural community in the of forest canopy and understory vegetation in the upland zone.
Small Streams	
Provide travelways for the full range of species associated with old-forest and riparian habitats. Assume free movement across the channel.	Establish old-forest zones that measure 300 to 1200 feet from edge to edge. The riparian zone (stream channel, floodplain, and upland areas) is included within the old forest zone (Figure 2). Use Table 4 to determine appropriate widths.
Large Streams	
Provide yearlong and seasonal habitat for species associated with older forests. The stream channel may be a barrier to movement for many species inhabiting the adjacent forest in the lower reaches.	Establish old-forest zones that measure 1200-1650 feet. The 1650 foot zone guideline is recommended (See Appendix A for explanation and other useful data). Where the stream channel is not a barrier, the riparian zone channel, floodplain, and upland habitat should be included within the old-forest zone. Where the channel or floodplain are barriers to movement, establish old-forest zones on both sides of the floodplain, beginning at the interface of the 100 year floodplain and adjacent upland.
Provide travelways for the entire range of vertebrates assoc. with old-forest and riparian habitats	The guideline for yearlong habitat above will provide adequate conditions for free movement of vertebrates associated with old-forest and riparian habitats.
Rivers	
Provide yearlong and seasonal habitat for species associated with older forests. The stream channel is a barrier to movement of many species inhabiting the adjacent forest.	Establish old-forest zones that measure 1200 to 1650 feet wide on each side of the stream channel beginning at the edge of the 100-year floodplain. The 1650 foot zone guideline is recommended (See Appendix A for explanation and other useful data).
Provide travelways for the entire range of vertebrates assoc. with old-forest and riparian habitats.	The guideline for yearlong habitat under large streams will provide adequate conditions for free movement of vertebrates associated with older forests and riparian habitats.

It may be necessary to designate long-term and short-term connectors, depending on existing suitable habitat, the potential natural vegetation, and the most desirable location in the long term. Some factors which can be used to determine optimum placement and frequency are: 1) location of existing or potential natural vegetation (site potential); 2) topography (e.g. saddles may be more utilized by species such as marten and fisher); 3) existing stream channels, thereby increasing stream protection; 4) areas with historical sightings of associated species, such as marten and fisher; and 5) areas known or suspected to be especially valuable to wildlife, such as the confluence of multiple headwaters.

B. Recommended Stand Conditions For Old-Forest Habitats.

The recommendations for late-seral-stage forest habitats presented here should be applied to the large blocks of late-seral-stage forests, the old-forest zone of the Riparian/Old-Forest Network, and the connectors. These recommendations should not be applied to the uplands in riparian zones (Figure 2); the upland portion of the riparian zones described in these recommendations should be managed as prescribed in Appendix F of the LRMP.

Overall, there are very few studies of wildlife and fish habitat relationships in older forests of the Sierra Nevada. Therefore, local habitat relationships information must be largely extrapolated from other regions. Focusing management of late-seral-stage habitats on all the structural components that have been consistently correlated with high wildlife use in older forests of the Pacific Northwest is recommended for conserving the associated species and communities of wildlife over time. The underlying assumption with this approach is that vertebrates associated with older forest should find suitable conditions in habitats that closely resemble the natural state in which they evolved. There are obvious shortcomings with assuming similar forest relationships for the Sierra Nevada and the Pacific Northwest. However, the overall relationships between fish and wildlife habitat and older forests are generally consistent over many study areas and local assumptions based on good research from an adjacent region do not appear to be unreasonable. Therefore, providing the habitat conditions that have been correlated with high wildlife and fish use in the Pacific Northwest should be an objective for late-seral-stage wildlife habitats on the TNF.

The habitat elements that are consistently correlated with high habitat quality for wildlife associated with older forests are: 1) large overstory trees; 2) large logs; 3) large snags; 4) vertical within-stand diversity; and 5) diversity among stands. Large trees in the overstory vegetation provide a critical habitat component for some wildlife. The large trees indirectly regulate the cool, moist condition on the forest floor that is needed for other species. The trees in mature forests also represent the recruitment pool for large snags and logs over time. Large snags and logs are the most important factors for many wildlife species associated with older forests. Therefore, large overstory trees should be managed to provide canopy habitats, cool and moist soil conditions on the forest floor, and recruitment of large logs and snags in late-seral-stage habitats.

The Ecosystem Classification Project of the Pacific Southwest Region's Ecology Program offers an excellent source of data for identifying characteristics of large trees, snags, and logs in natural forests. Useful data for these attributes can be obtained for the major forest types (mixed-conifer, red fir, and eastside pine) on the Tahoe National Forest. These data will soon be available for each site productivity class within the major forest types and can be used as

guidelines for managing large trees, snags, logs, and number of canopy layers in late-seral-stage forests (see Table 6 for an example of these data). The guidelines can then be used to explore potential silvicultural methods for perpetuating the desired arrangements of key habitat elements over time. This approach is highly recommended.

Guidelines for managing structural diversity on vertical and horizontal scales cannot be explicitly developed from available habitat relationships information. Therefore, managing old-forest habitats to provide the patterns of vertical and horizontal structural diversity found in natural forests is recommended. A useful source of horizontal diversity patterns is not available at this time. However, researching landscape patterns at varying scales, as recommended in Section I.B (p.7), may provide these data.

Table 6. Example of the types of data that can be developed from the PSW Ecosystem Classification Project.

MIXED CONIFER FOREST TYPE

	Dunning Site Classes		
Habitat Characteristic	***1A - 1***	***2 - 3***	***4 - 5***
Trees > 39" DBH/Acre	11 (2)*	8 (2)	10 (3)
Logs > 10" Diameter/Acre	**	**	**
Snags >20" DHB/Acre	2.7 (1.5)	3.8 (1.8)	2.0 (.7)
Snags 10-20" DBH/Acre	3.8 (2.2)	2.6 (2.7)	.2 (.7)
No. Canopy Layers	2-3	2-3	2-3

** Mean (standard error).* *** Data are being developed.*

Source: Fites, Jo Ann. 1991. Draft Ecological Old-Growth Definitions for Mixed Conifer (SAFTYPE 243) in California.

C. Adaptive Management Elements

The program for managing late-seral-stage forests and riparian habitats recommended by The Wildlife and Fisheries Working Group is offered as a set of working hypotheses that deserve rigorous scrutiny and testing. Several measures are recommended to allow additional analysis of the recommended program. Some monitoring and research activities are also recommended to provide the feedback needed by managers to make appropriate program adjustments as local knowledge increases.

1. Program Evaluation

The recommendations for managing late-seral-stage-forest and riparian habitats should be regarded as a starting point for rigorous testing and analysis. The recommendations were made from the best available information. However, specific information for the Sierra Nevada is limited and most habitat relationships for this project were extrapolated from other regions.

The recommended management program may be viewed as conservative toward wildlife because the species with the most limiting habitat associations were occasionally used to suggest management objectives. However, the recommended landscape design does not provide small, scattered old-forest blocks or other habitat arrangements that may be needed to conserve marten or fisher. Important habitat elements may be lacking for other species as well. In addition, the TNF Staff has asked if the proposed program must be applied to the entire landscape of the TNF to maintain viable populations of vertebrates associated with old-forest and riparian habitats. These questions cannot be satisfactorily answered without more sophisticated analyses.

Several tools for evaluating forest management at the landscape level are available. These would permit the TNF to evaluate alternative management strategies in relation to conservation of individual wildlife populations, timber yield, water yield, and economics. Further, some tools would allow the TNF to experimentally test hypotheses and analyze the adequacy of the proposed program for conserving populations of wildlife species. While local adaptations of existing tools is necessary, a serious effort to organize a system of state-of-the-art analysis tools is recommended. These tools would allow the TNF to complete high-quality analyses that could be used to make more-informed management decisions and improve NEPA documents. Recommended tools and their applications are summarized below.

Geographic Information System. A geographic information system (GIS) is an essential component for efficient and meaningful analysis of long-term management of the Tahoe National Forest. The existing Distributed Wildland Resource Information System (DWRIS) lacks the analytical capabilities needed to simulate complex management problems over time. GIS software and supporting hardware should be in place before a reanalysis of the LRMP begins. Acquisition of these tools should be a high forest priority.

Vegetation Change Simulators. Staff at the University of California are presently developing methods for integrating vegetation succession with spatial simulations of forest management. Similar projects are underway in other regions. Integration of vegetation succession with GIS software is also recommended. This action will allow the forest to evaluate the spatial and

temporal characteristics of the Forest under alternative management strategies. Integration of vegetation succession with a GIS should be regarded as fundamental tools needed for forest and project-level planning today.

Wildlife Species Simulators. Several programs are available that could test hypotheses about the adequacy of the recommended management program on individual or groups of wildlife species. Examples are the landscape model developed by the Pacific Southwest Forest and Range Experiment Station for spotted owls and the wildlife habitat relationships pilots for the Klamath and Sierra Nevada bioregion projects. In addition, models that simulate habitat change at the stand and landscape levels are being used to evaluate habitat conditions for forest birds in Oregon. With some modification, many of these models could be linked with the vegetation simulation software in a GIS to evaluate the landscape patterns associated with long-term forest management strategies on individual or groups of wildlife species. Development of simulators that can be used to evaluate effects of management alternatives on local species is recommended. Models that evaluate habitat conditions for marten and fisher should be a high priority.

Integrated Software System. At least two projects in other regions are developing integrated software packages that can be used to simultaneously evaluate the effects of alternative land management strategies on several resources including wildlife, water, timber yield, and economics. These systems are linked with a GIS to allow analyses of spatial trends in landscapes. An integrated system that could evaluate the effects of management on wildlife, water, soils, timber yield, and economics would provide a powerful analysis tool for forest and project-level planning. Without an integrated system, it will be extremely difficult to answer many prevailing questions about the adequacy of the recommended program presented here or other forest management strategies.

2. Monitoring

A comprehensive plan for monitoring fish and wildlife was described in Appendix D of the LRMP. The three basic monitoring elements are: 1) evaluating compliance with management standards and guidelines; 2) post-project assessments of direct habitat improvements; and 3) monitoring trends in habitats and some populations. The monitoring program in the LRMP should be implemented as described.

3. Research

Many research projects could yield data to improve management of older forests, riparian areas, and biological diversity on the Tahoe National Forest and elsewhere. Three projects with particular value are: 1) researching patterns of presettlement forests at several landscape scales; 2) evaluating the appropriate management methods for wildlife species associated with mature forest in eastside pine; and 3) describing potential natural conditions for key fish and wildlife habitat elements in older forests and riparian areas. Projects to address these subjects should be a high priority for the Forest Service in the Sierra Nevada. Other valuable research projects include: 1) life-history and habitat relationships information for rare species such as the fisher,

wolverine, and great gray owl; 2) landscape pattern effects on wildlife and fish; and 3) wildlife and fish habitat relationships with key habitat elements in older forests and riparian habitats.

D. SUGGESTIONS FOR IMPLEMENTATION

1. Maintaining Project Options

The Tahoe National Forest will undoubtedly require a considerable amount of time to evaluate the recommendations presented here, develop alternative management themes, select a preferred management strategy for older forests and riparian areas, and amend the Tahoe Land and Resource Management Plan as appropriate. While the analysis proceeds, maintaining options for a forest management program for late-seral-stage-forest and riparian habitats is recommended. Options can be maintained by: 1) identifying the lands that would be needed to implement the recommended program; 2) identifying other tracts of older forest that could be used for alternative programs or substitute sites for unsuitable conditions in the recommended landscape; 3) identifying other biologically important areas (ridgetop travelways, unique habitats, biologically rich areas); and 4) describing the effects of project-level management on areas identified in steps 1-3 in associated NEPA documents. This combination of actions is recommended.

2. Assessing Long-Term and Short-Term Effects

A complete set of recommendations for managing late-seral-stage-forest and riparian habitats cannot be made until the conservation strategy for the California spotted owl is revisited. However, much can be done now to evaluate the recommendations made here.

Assessing the effectiveness of implementing the Old-Forest/Riparian System can begin immediately. Therefore, ranger district staffs should be asked to layout landscapes to implement the network guidelines. This work should disclose strengths and weaknesses of the network approach and should indicate the degree to which current landscapes can be used to meet the desired short-term and long-term conditions. Where existing conditions are incompatible with the guidelines, such as "checkerboard" land ownership patterns, districts should explore alternative designs. Such evaluations will also allow analysis of the scale at which cooperative implementation among all involved will be necessary. Finally, the Forest Interdisciplinary Team should begin considering the management strategies necessary to change the existing forest condition to one that meets The Old-Forest/Riparian System guidelines.

Silvicultural systems which perpetuate the desired-stand characteristics in late-seral-stage forests should be explored. Data summaries for key habitat elements (large trees, snags, and logs) should be available this winter for at least one forest type. These data can be used by silviculturists to consider appropriate methods for perpetuating desired structural elements in older forests over time.

3. Watershed Planning

The Wildlife and Fish Working Group strongly recommends that TNF ranger districts change the resource planning units from the traditional timber compartments to subwatersheds of roughly 2,000 to 10,000 acres. This change would offer many advantages. For example, using subwatersheds would allow hydrologists and fisheries biologists to describe the desired-future condition for a complete stream system. By this method, the need to protect ephemeral streams, seeps, and other local conditions can be evaluated in the context of their relationships to the entire stream system. In addition, wildlife habitat planning and analysis would be more meaningful if subwatersheds were used as the basic units for project planning.

GLOSSARY

Aquatic ecosystem: Any body of water, such as a stream, lake, or estuary, and all of the organisms and nonliving components, functioning as a natural system.

Backwater: An off-channel pool or eddy at lateral margins of the channel. Protected from high velocity flows, usually by abundant woody debris or boulders.

Bank stability: The ability of stream banks to withstand the erosive forces of water. Bank stability increases in the presence of deeply rooted plants.

Benthic: Pertaining to the river bed or lake floor. 2) Living on or within the the substrates of aquatic habitats.

Biological Diversity: The variety of all plants and animals, the ecological roles they perform, and the genetic diversity they contain.

Blowdown: A tree or trees uprooted or felled by wind.

Buffer: An area of vegetation left or managed to reduce the impact of a treatment or action of one area on another.

Channel: A waterway that contains moving water either periodically or continuously.

Connectivity: Unbroken linkages in a landscape, typified by streams and riparian areas.

Connectors: A basic component of the Old-Forest/Riparian Network. Areas delineated to maintain landscape connectivity by providing linkages of old-forest habitat, especially among watersheds.

Cumulative Effects: Impacts that operate collectively, often resulting in overall effects that are greater than the sum of individual impacts.

Debris Dam: An accumulation of many sizes of woody debris, generally within the stream channel, but often extending onto the banks or low terraces. Also referred to as debris jams, they may be naturally occurring or the result of poor management.

Edges: Areas where two physical or biological zones meet (ecotones).

Edge Effects: The biological and abiotic actions operating at edges. Examples are increases in productivity, species richness, nest parasitism, and predation.

Ephemeral Stream: A water drainage that flows only in direct response to precipitation. It receives little or no water from springs and no long-continued supply from snow or other sources. Its channel is at all times above the water table.

Floodplain: Relatively flat surfaces adjacent to active channels, formed by deposition of sediments during major flood events. It may be covered by water at flood flows.

Fragmented: Reduced in size and connectivity. The degree of fragmentation is dependant upon scale (in space and time) and species specific life requisites.

Headwaters: Places of stream origins (including springs and seeps). Usually first order perennial or intermittent streams. In terms of old-forests, headwater riparian areas do not function as barriers to free movement of animals in adjacent forest habitats.

Interior-Forest Habitat: The inside of a mature forest block where edge effects are minor and insignificant.

Forest-wide: Pertaining to, or operating over an entire National Forest.

Large Streams: Usually third order or larger. Large stream riparian areas may act as a barrier to movement of many species associated with adjacent old-forest habitats.

Landscape: A heterogeneous land area composed of a cluster of interacting ecosystems that is repeated in similar form throughout. Landscapes vary in size, down to a few square kilometers.

Large-Woody Debris (LWD): Large pieces of logs, limbs, trees, branches, bark, that accumulate, often in riparian areas. May be naturally occurring or a result of human activities.

Late-Seral-Stage Forest (Old Forest, Older Forest): A forest where later stages of stand development are present, tree growth has slowed, and large green trees, snags, and downed log levels are a predominant feature.

Matrix: The most extensive and most connected landscape element type present, which plays the dominant role in landscape functioning.

Natural Patch Dynamics: The turnover and movement of patches (in a landscape) in time and space as a result of geomorphology, climate, the establishment of plants and animals, soil development and natural disturbance.

Old-Forest: see Late-Seral-Stage Forest.

Old-Forest Blocks: Those areas of the Old-Forest/Riparian System delineated to provide large, unfragmented tracts of old-forest that are capable of supporting sub-populations of species that live in forest interior habitats.

Old-Forest/Riparian System: The combination of Old-Forest Blocks and Riparian/Old-Forest Network.

Old-Forest Zone: The upslope area of the Riparian/Old Forest Network (which includes the uplands of riparian zone) that is expected to function as yearlong forest interior habitat and/or travelways for wildlife.

Patch: An assemblage of similar vegetation.

Project Level: Activities associated with planning or implementing field projects. Examples are timber sales and wildlife habitat improvements.

Riparian: Referring to the terrestrial area, or the organisms associated with this area, where the vegetation and microclimate are influenced by perennial and/or intermittent water, associated with high water tables and soils which exhibit some wetness characteristics.

Riparian/Old-Forest Network: The combination of Riparian Zones and Old-Forest Zones designed to provide continuous connectivity to the Old-Forest/Riparian System, as well as the attributes of the Zones themselves.

Riparian Vegetation: Vegetation requiring free or unbound water. Plants typically found associated with the conditions provided by streamside environments. Examples are willows and alders.

Riparian Zone: The area in the Riparian/Old-Forest Network that includes the active stream channel, floodplain, riparian vegetation and upland areas which directly influence the riparian ecosystem.

Small Streams: Usually first to third order perennial streams. In terms of old-forest wildlife species, small stream riparian areas do not present a barrier to animal movement.

Stand: A community of trees or other vegetation which is sufficiently uniform in composition, constitution, age, spatial arrangement or condition to be distinguishable from adjacent communities.

Stream Order: A method of ordering streams as part of a drainage basin network, where the smallest unbranched tributary is called first-order. Streams receiving two first-order tributaries are second-order streams and so on.

Upland Areas: The upslope areas adjacent to the stream channel and floodplain which directly influence the stream environment or floodplain.

Vertebrates: Organisms with backbones: amphibians, reptiles, birds, and mammals.

Watershed: The area drained by a river or stream and its tributaries.

Wildlife: Those native and desired non-native vertebrate species found on the Tahoe National Forest.

APPENDIX A

Determining Old-Forest Zone Widths

Below are listed home-range sizes for species associated with old-forest habitats (see summary document for fish and wildlife habitat relationships in late-seral-stage forests) These sizes were used to determine the widths of the old-forest zone portion of the network providing yearlong and seasonal habitat (adjacent to large streams and rivers). The diameters given assume circular home-ranges because circles are the most defensible home range shapes when empirical information is lacking.

Where possible, the recommended width is 1650 feet; this accommodates a 50 acre circular home range and would provide yearlong or seasonal habitat for those species with more circular habitat use patterns. Martens and fishers probably don't use circular home ranges. These animals generally use long, narrow areas which are provided by the System design.

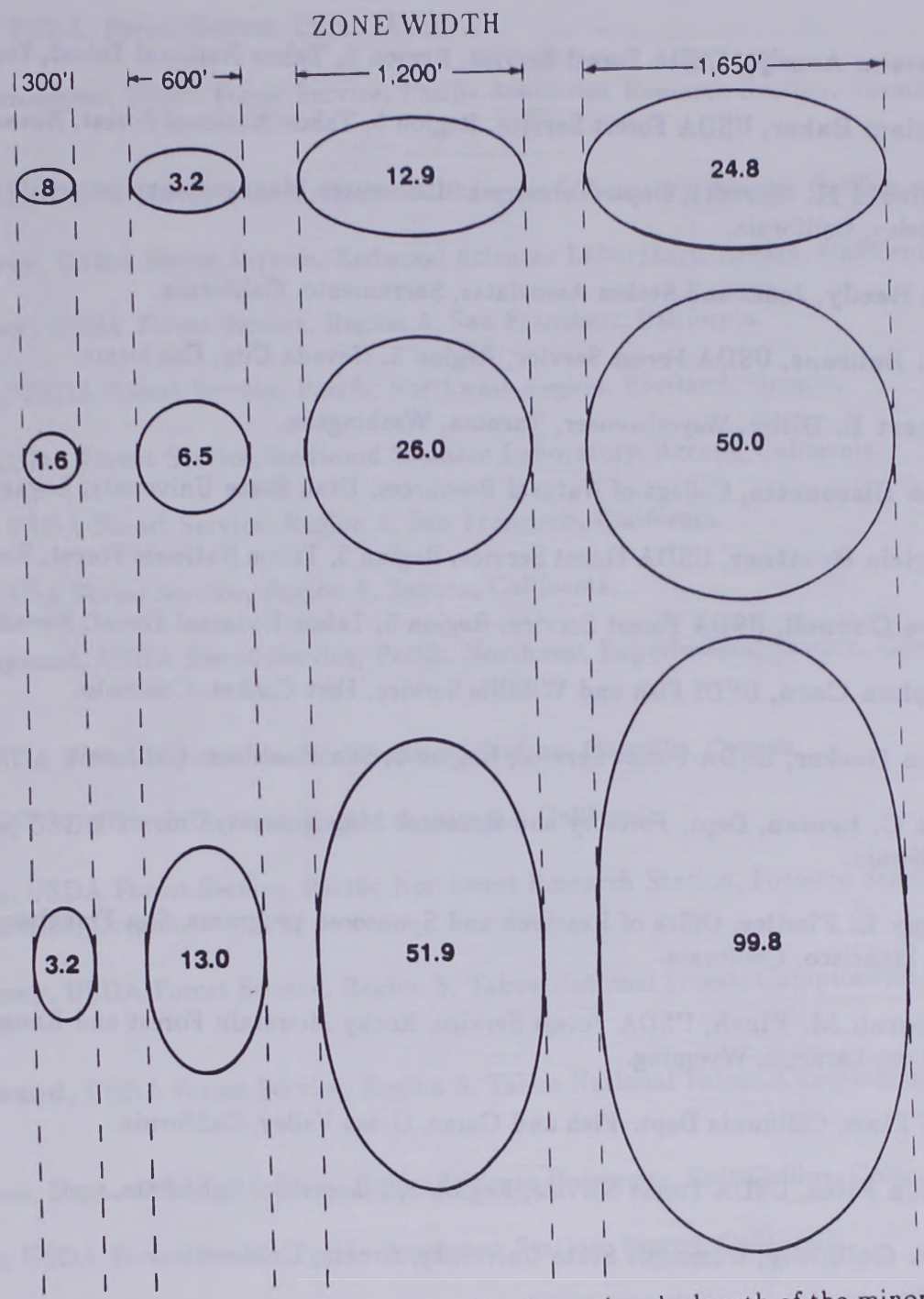
Also provided are additional possible home-range shapes and associated diameters. These are provided to allow evaluation of alternative management strategies for specific projects and to develop risk assessments for assuming different home range shapes.

Home-Range Sizes for Old-Forest Wildlife

Species	Home-Range *Size (acres)*	*Diameter (ft.)*
Ensatina	<1	<236
Hammond's Flycatcher	2	333
Winter Wren	2	333
Red-breasted Nuthatch	4	471
Pygmy Nuthatch	5	527
Golden-crowned Kinglet	5	527
Hairy and Downy Woodpeckers	10-15	745-912
Brown Creeper	16	942
Pine Grosbeak	26	1201
Northern Flying Squirrel	31-77	1311-2067
Ermine	37	1432
Goshawk	50*	1665
Pileated Woodpecker	50*	1665
Marten	80-120*	2106-2580
Fisher	80-120*	2106-2580

* Denotes minimum patch size.
Note: Home-range diameters based on a circular home range shape.

The following illustration provides a means of comparing a particular zone width and the potential home-range area provided by different home-range shapes.



** Note: Elipses have been drawn with the major axis being twice the length of the minor axis and are illustrated with the long axis both perpendicular and parallel to the associated zone edge. The home-range area that the shape accomodates is located within the shape and reported in acres.

Appendix B

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APPENDIX C

INDIVIDUAL SPECIES REVIEWED

Riparian-Associated Vertebrates on the Tahoe National Forest

SPECIES	*REASON SELECTED*
Ensatina	Strong association with large logs and tree bark
Mt. Yellow-legged frog	Water is essential for life cycle
W. Terr. Garter Snake	Prefers streamside habitats
Wood duck	Nests in cavities near water
Yellow-bellied Sapsucker	Represents resident primary cavity nesters
Downy Woodpecker	Nests in cavities near water
Willow Flycatcher	Needs willows near water for nesting and feeding
Western Flycatcher	Needs forest habitat near water
House Wren	Likes shrub Habitats and logs near water
Wilson's Warbler	Very strong association with riparian habitats
Yellow Warbler	Very strong association with riparian habitats
Black-headed Grosbeak	Nests in deciduous shrubs near water
Lincoln's Sparrow	Prefers moist areas with deciduous shrubs
Song Sparrow	Prefers moist areas with deciduous shrubs
Dusky Shrew	Prefers forested habitats near water
Vagrant Shrew	Prefers large logs near water
Water Shrew	Prefers large logs near water
Ornate Shrew	Prefers riparian habitats
Western Jumping Mouse	Prefers wet areas with herbs and logs
Mountain Beaver	Prefers riparian habitats

Old-Forest-Associated Vertebrates on the Tahoe National Forest

SPECIES	*REASON SELECTED* **Strong association with:**
Ensatina	large logs and tree bark
Goshawk	mature forest habitats
Pileated Woodpecker	mature forest habitats
Hairy Woodpecker	snags
Red-breasted Nuthatch	mature forest habitats
Pygmy Nuthatch	older pine forests
Brown Creeper	mature forest habitats
Golden-crowned Kinglet	mature forest habitats
Winter Wren	mature forest habitats
Hammond's Flycatcher	mature forest habitats
Pine Grosbeak	older lodgepole pines
Evening Grosbeak	mature fir forests
No. Flying Squirrel	mature forest habitats
Sierra Nevada Red Fox	mature forest habitats
Marten	mature forest habitats
Fisher	mature forest habitats
Ermine	mature forest habitats
Black Bear	mature forest habitats

FIGURE 1. A CONCEPTUAL LAYOUT OF THE OLD-FOREST/RIPARIAN SYSTEM ON THE TAHOE NATIONAL FOREST.

FIGURE 2. THE RIPARIAN/OLD FOREST NETWORK.

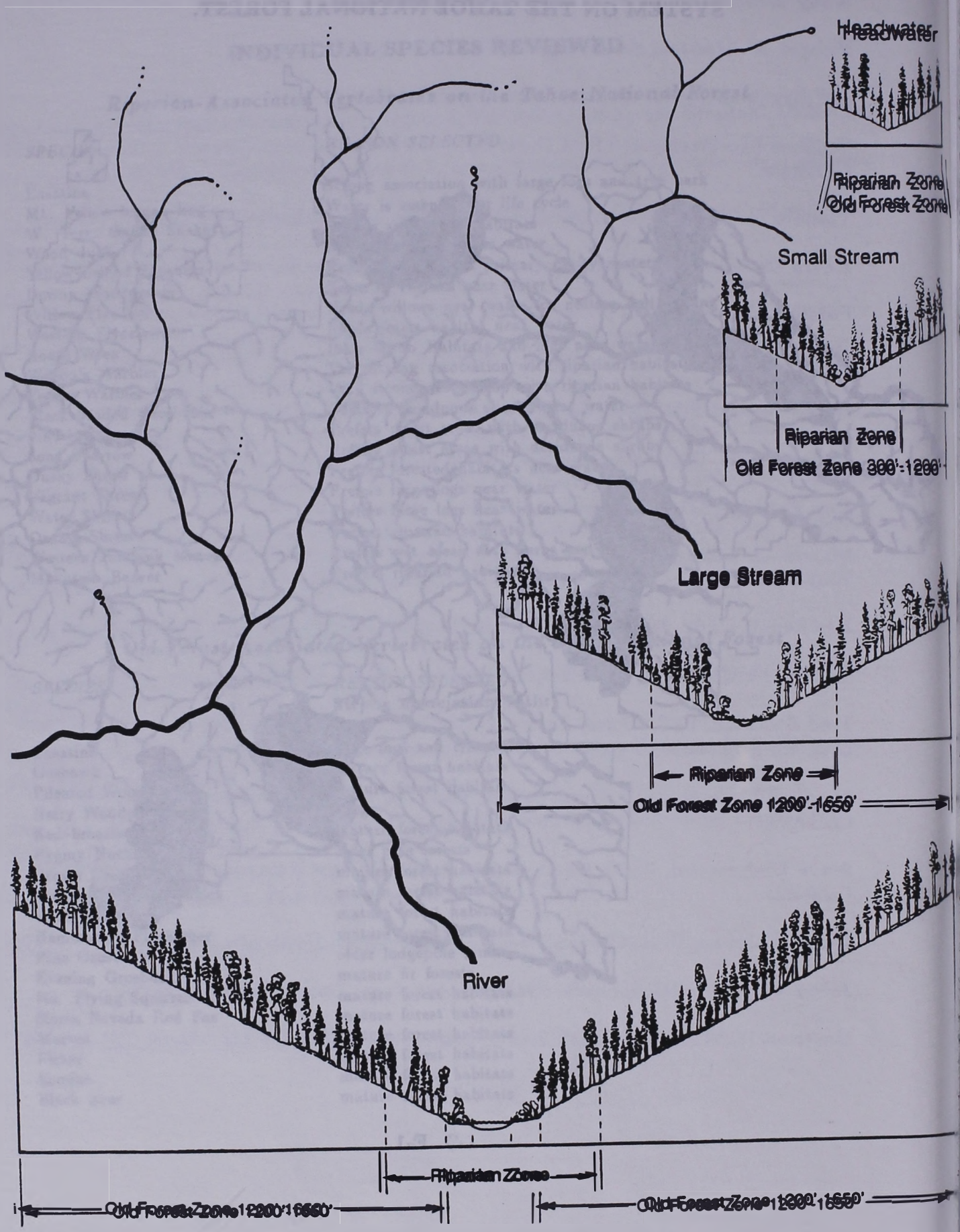

FIGURE 3. PLACEMENT OF CONNECTORS.